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(54) **METHODS AND APPARATUS FOR DISTRIBUTED BASEBAND SIGNAL PROCESSING FOR FIFTH GENERATION (5G) NEW RADIO DOWNLINK SIGNALS**

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(52) **U.S. Cl.**

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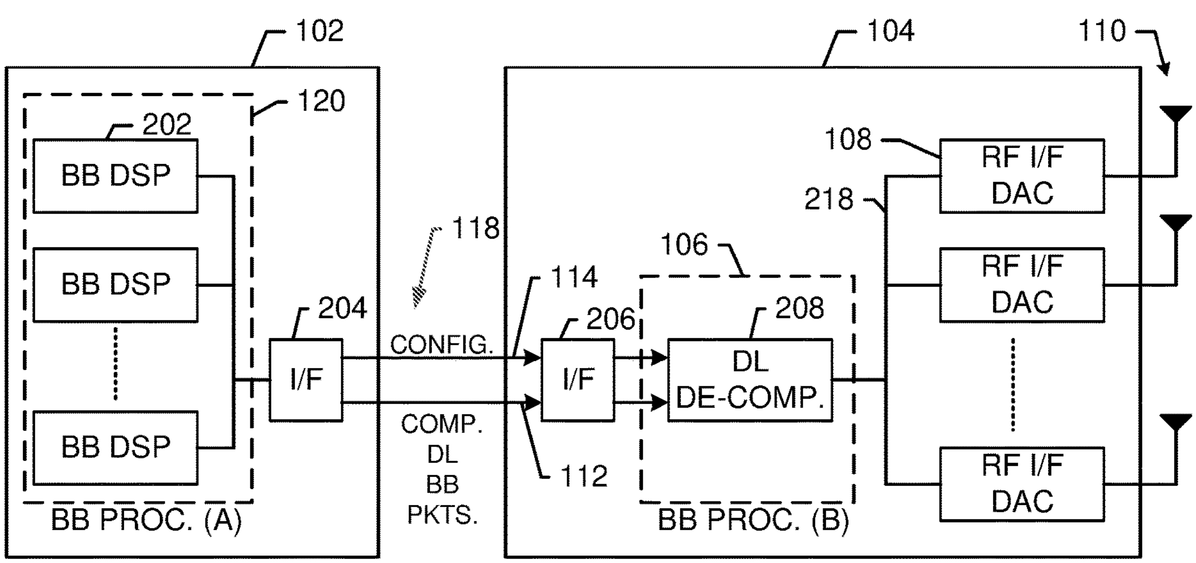
(57) **ABSTRACT**

Methods and apparatus for baseband signal compression of fifth generation new radio downlink signals. In an embodiment, a method includes receiving compressed packets over a transmission medium from a central office that performs a first portion of baseband processing to generate the compressed packets from downlink data, receiving configuration parameters, performing a second portion of baseband processing to decompress the compressed packets using the configuration parameters to generate the downlink data, and transmitting the downlink data. An apparatus includes an interface that receives compressed packets and configuration parameters over a transmission medium from a central office that includes a first baseband processing section that generate the compressed packets from downlink data. The apparatus also includes a second baseband processing section that decompresses the compressed packets using the configuration parameters to extract the downlink data, and a radio frequency (RF) interface that transmits the downlink data.



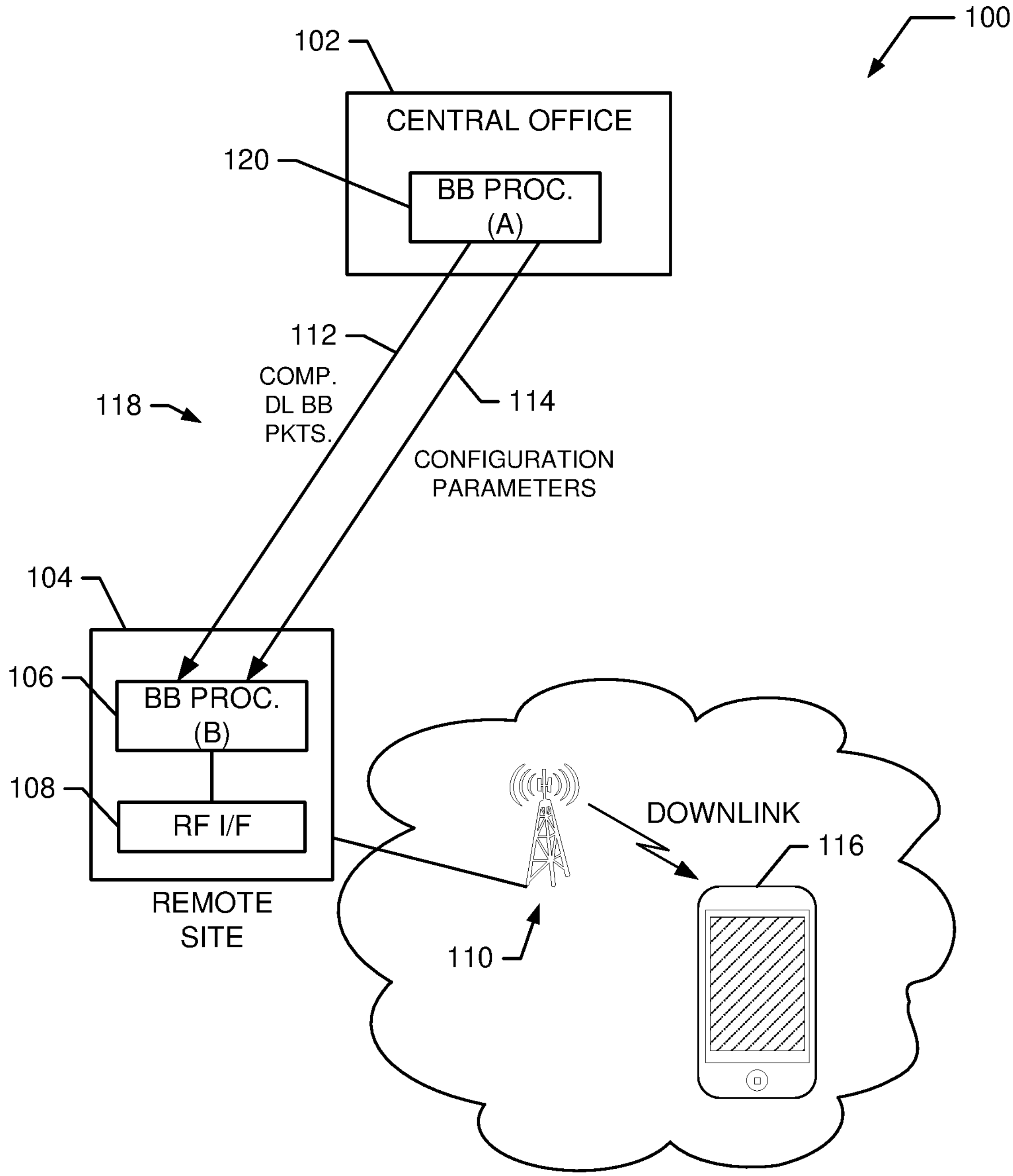

100
102
CENTRAL OFFICE
120
BB PROC.
(A)
112
COMP.
DL BB
PKTS.
118
114
CONFIGURATION
PARAMETERS
104
106
BB PROC.
(B)
108
RF I/F
REMOTE
SITE
DOWNLINK
116
110

FIG. 1

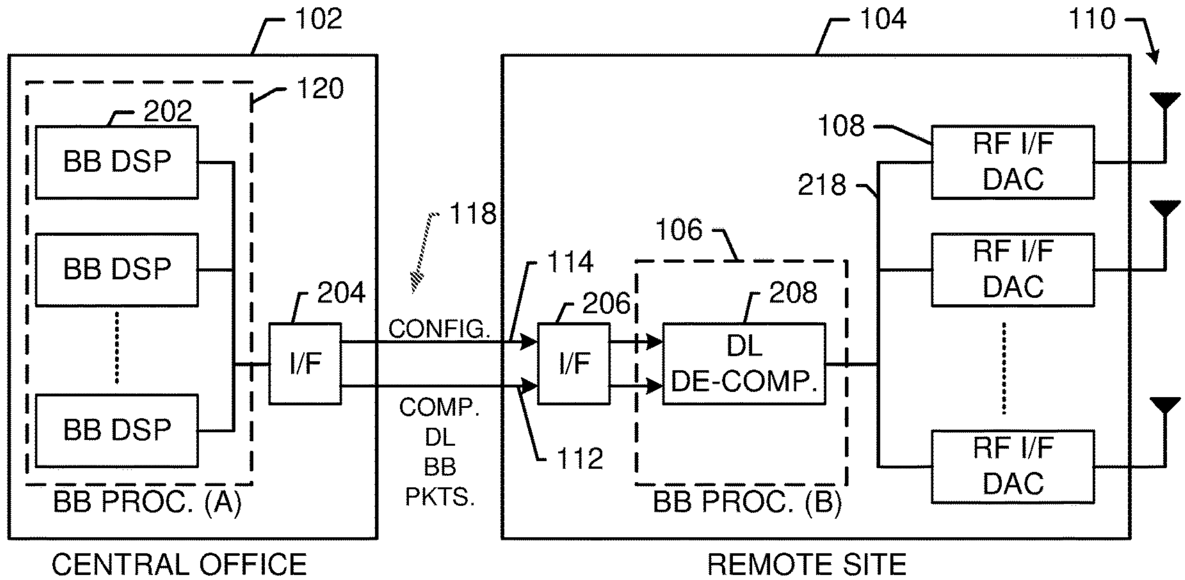


FIG. 2

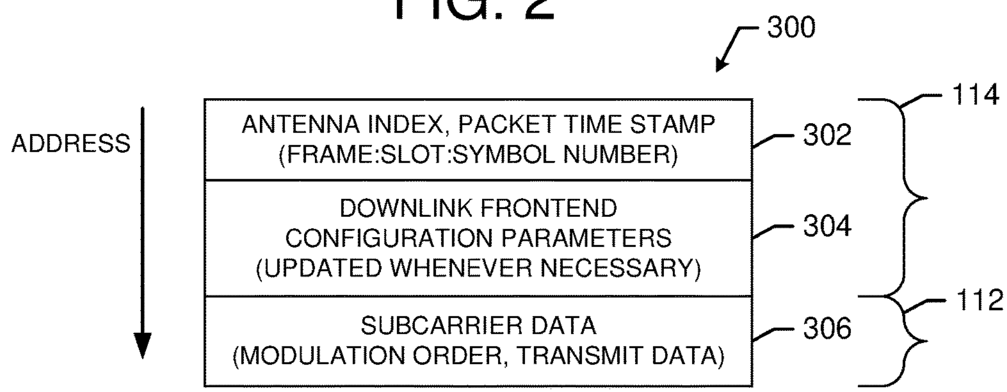


FIG. 3

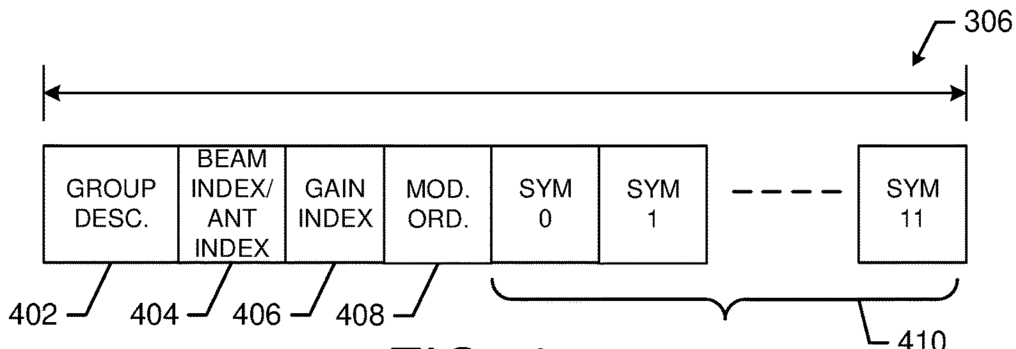


FIG. 4

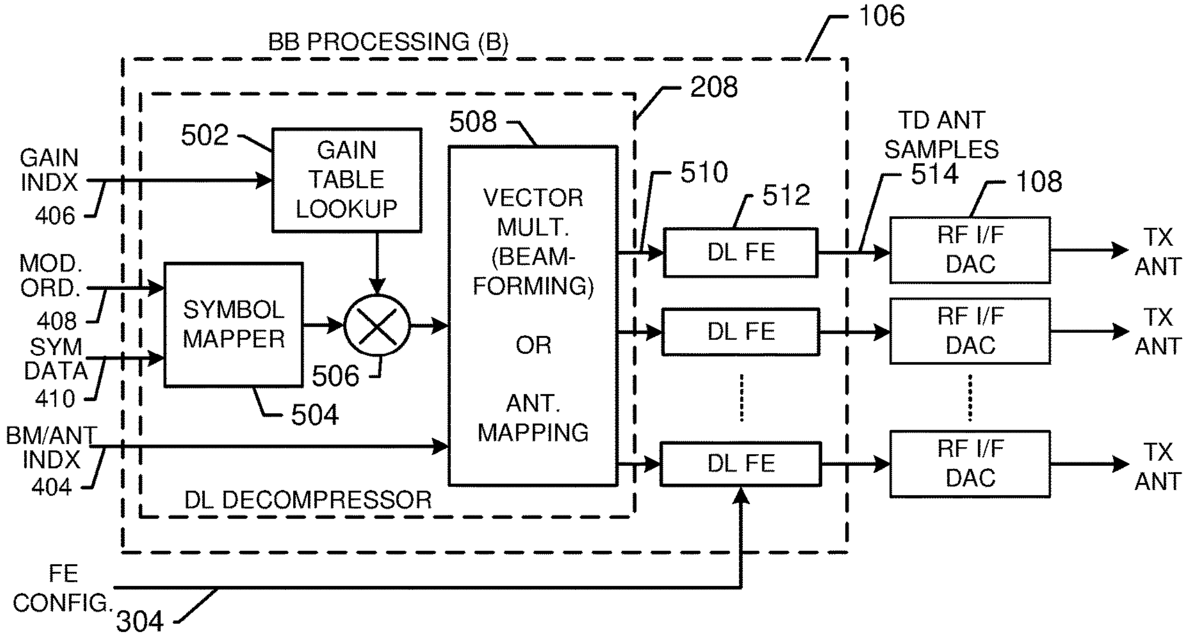

106
BB PROCESSING (B)
208
DL DECOMPRESSOR
GAIN INDX
406
502
GAIN TABLE LOOKUP
MOD. ORD.
408
SYM DATA
410
SYMBOL MAPPER
504
506
508
VECTOR MULT. (BEAM-FORMING) OR ANT. MAPPING
BM/ANT INDX
404
510
512
DL FE
DL FE
DL FE
TD ANT SAMPLES
514
108
RF I/F DAC
RF I/F DAC
RF I/F DAC
TX ANT
TX ANT
TX ANT
FE CONFIG.
304

FIG. 5

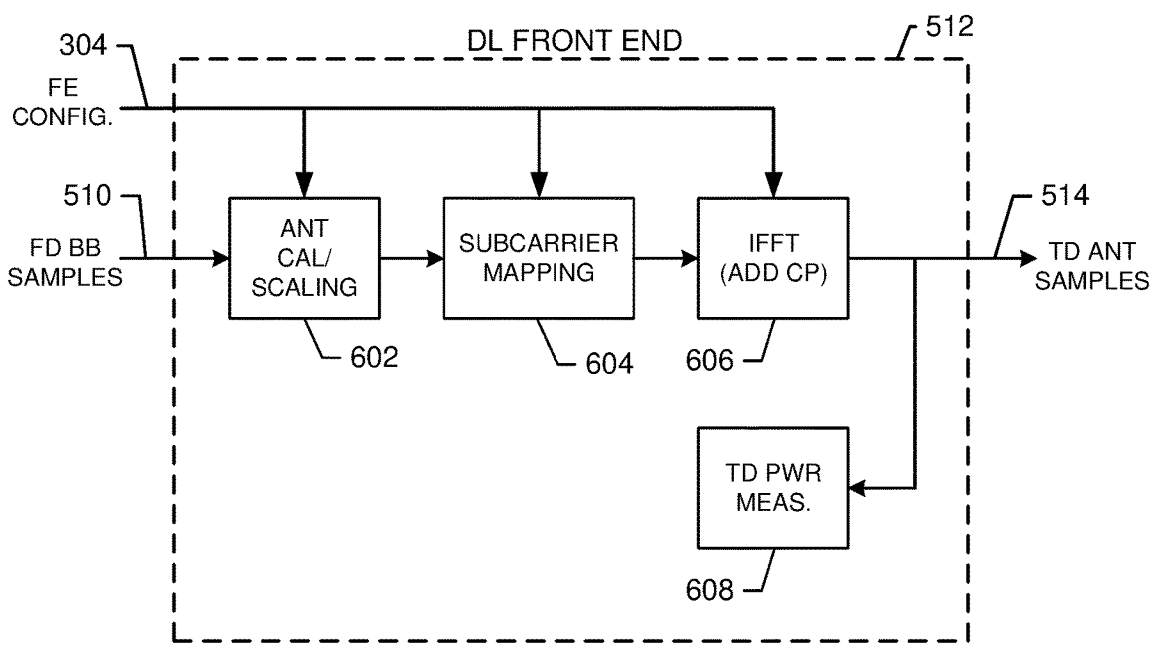

DL FRONT END
512
304
FE CONFIG.
510
FD BB SAMPLES
ANT CAL/ SCALING
602
SUBCARRIER MAPPING
604
IFFT (ADD CP)
606
TD PWR MEAS.
608
514
TD ANT SAMPLES

FIG. 6

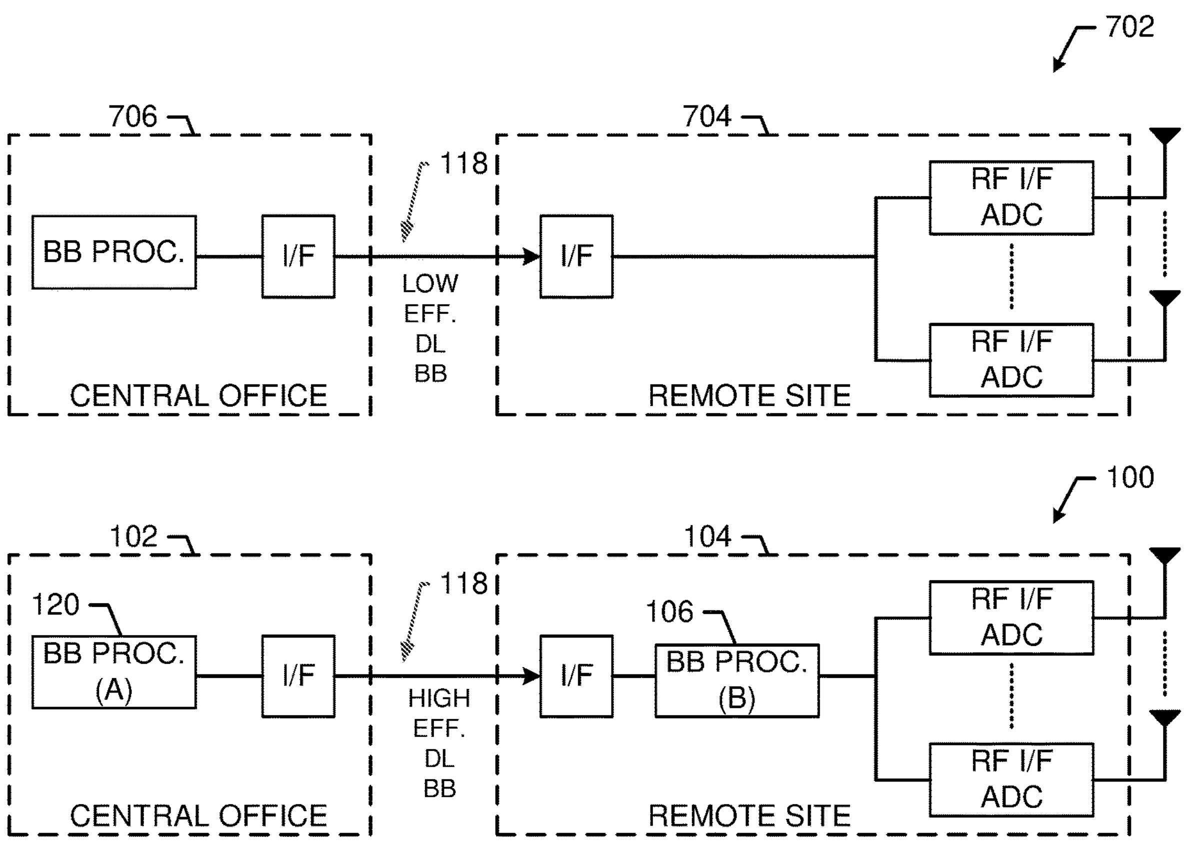

702
706
704
118
BB PROC.
I/F
I/F
RF I/F
ADC
RF I/F
ADC
LOW
EFF.
DL
BB
CENTRAL OFFICE
REMOTE SITE
100
102
104
118
120
106
BB PROC.
(A)
I/F
I/F
BB PROC.
(B)
RF I/F
ADC
RF I/F
ADC
HIGH
EFF.
DL
BB
CENTRAL OFFICE
REMOTE SITE

FIG. 7

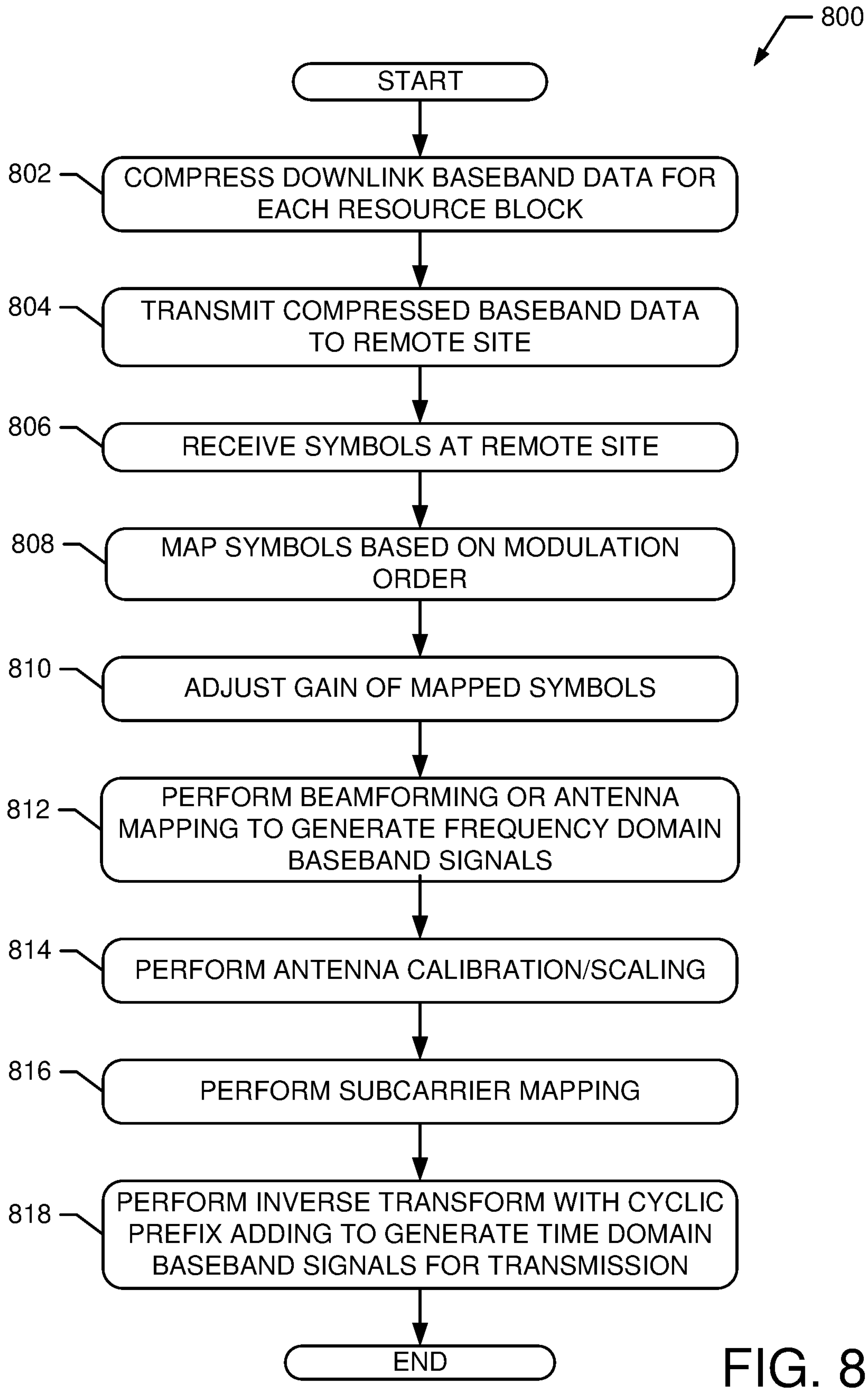

800
START
802
COMPRESS DOWNLINK BASEBAND DATA FOR EACH RESOURCE BLOCK
804
TRANSMIT COMPRESSED BASEBAND DATA TO REMOTE SITE
806
RECEIVE SYMBOLS AT REMOTE SITE
808
MAP SYMBOLS BASED ON MODULATION ORDER
810
ADJUST GAIN OF MAPPED SYMBOLS
812
PERFORM BEAMFORMING OR ANTENNA MAPPING TO GENERATE FREQUENCY DOMAIN BASEBAND SIGNALS
814
PERFORM ANTENNA CALIBRATION/SCALING
816
PERFORM SUBCARRIER MAPPING
818
PERFORM INVERSE TRANSFORM WITH CYCLIC PREFIX ADDING TO GENERATE TIME DOMAIN BASEBAND SIGNALS FOR TRANSMISSION
END

FIG. 8

METHODS AND APPARATUS FOR DISTRIBUTED BASEBAND SIGNAL PROCESSING FOR FIFTH GENERATION (5G) NEW RADIO DOWNLINK SIGNALS

PRIORITY

[0001] This application is a continuation of a U.S. patent application having an application Ser. No. 16/536,828, filed on Aug. 9, 2019, and entitled "Methods and Apparatus for Distributed Baseband Signal Processing of Fifth Generation (5G) New Radio Downlink Signals," which further claims priority from U.S. Provisional Application No. 62/849,029, filed on May 16, 2019, and entitled "Method and Apparatus for Baseband Signal Compression of 5G NR downlink," all of which are hereby incorporated herein by reference in their entirety.

FIELD

[0002] The exemplary embodiments of the present invention relate to operation of telecommunications networks. More specifically, the exemplary embodiments of the present invention relate to receiving and processing data streams for use in wireless telecommunication networks.

BACKGROUND

[0003] With a rapidly growing trend of mobile and remote data access over a high-speed communication networks, such as Long Term Evolution (LTE), fourth generation (4G), and fifth generation (5G) wireless networks, accurately delivering and deciphering data streams become increasingly challenging and difficult.

[0004] During downlink operation, baseband signals at a central office need to be transmitted to remote sites for transmission to user equipment. Typically, wireless operators utilize leased data lines to transmit information between the central office and the remote sites. It is desirable to use these leased lines as efficiently as possible to allow the use of less expensive lines or allow the transmission of more 5G channels using the existing lines.

[0005] Therefore, it is desirable to have a system that enables efficient transmission of downlink baseband signals from a central office to remote sites.

SUMMARY

[0006] In various exemplary embodiments, a downlink transmission system comprising methods and apparatus are provided for transmission of downlink signals from a central office to remote sites. In an embodiment, a primitive downlink baseband signal vector is defined for each resource block as beam (or antenna) index/gain, index/modulation, or order/modulation data. In an embodiment, a 5G NR symbol (OFDMA symbol) is compressed with a packet comprising multiple primitive data vectors and transferred from the baseband signal processor in the central office to the remote radio head at the antenna site. By utilizing a downlink baseband front-end and decompressor (symbol mapper+beamformer), the remote radio head can successfully decompress the downlink baseband signal information to the time domain sequences, which is directly upshifted and transferred via transmit antennas.

[0007] The various embodiments are fully compliant with 5G NR standards without adding any other side information, provide ultra-low latency since the required procedures are straightforward and don't include time-consuming or complicated signal processing, and provide computation power savings at the central office by offloading downlink signal processing to remote sites.

[0008] In an embodiment, a method is provided that includes receiving compressed packets over a transmission medium from a central office that performs a first portion of baseband processing to generate the compressed packets from downlink data, receiving configuration parameters, performing a second portion of baseband processing to decompress the compressed packets using the configuration parameters to generate the downlink data, and transmitting the downlink data.

[0009] In an embodiment, an apparatus is provided that includes an interface that receives compressed packets and configuration parameters over a transmission medium from a central office that includes a first baseband processing section that generate the compressed packets from downlink data. The apparatus also includes a second baseband processing section that decompresses the compressed packets using the configuration parameters to extract the downlink data, and a radio frequency (RF) interface that transmits the downlink data.

[0010] Additional features and benefits of the exemplary embodiments of the present invention will become apparent from the detailed description, figures and claims set forth below.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The exemplary aspects of the present invention will be understood more fully from the detailed description given below and from the accompanying drawings of various embodiments of the invention, which, however, should not be taken to limit the invention to the specific embodiments, but are for explanation and understanding only.

[0012] FIG. **1** shows a block diagram of a communication network that includes an exemplary embodiment of a distributed downlink baseband processing system.

[0013] FIG. **2** shows an exemplary detailed embodiment of a central office and remote site shown in FIG. **1**.

[0014] FIG. **3** shows an exemplary compressed downlink data packet generated by an embodiment of a first baseband processing section and decompressed by an embodiment of a second baseband processing section.

[0015] FIG. **4** shows an embodiment of a compression format for each resource block of downlink subcarrier data.

[0016] FIG. **5** shows a detailed embodiment of the baseband processing section (B) that comprises the downlink decompressor shown in FIG. **2**.

[0017] FIG. **6** shows an exemplary embodiment of the downlink front end shown in FIG. **5**.

[0018] FIG. **7** illustrates how embodiments of the distributed downlink baseband processing system transmits downlink signals from a central office to a remote site with greater efficiency than conventional systems.

[0019] FIG. **8** shows an exemplary method for performing downlink baseband compression in accordance with exemplary embodiments of a distributed downlink baseband processing system.

DETAILED DESCRIPTION

[0020] Aspects of the present invention are described below in the context of methods and apparatus for compression of 5G new radio downlink signals.

[0021] The purpose of the following detailed description is to provide an understanding of one or more embodiments of the present invention. Those of ordinary skills in the art will realize that the following detailed description is illustrative only and is not intended to be in any way limiting. Other embodiments will readily suggest themselves to such skilled persons having the benefit of this disclosure and/or description.

[0022] In the interest of clarity, not all of the routine features of the implementations described herein are shown and described. It will, of course, be understood that in the development of any such actual implementation, numerous implementation-specific decisions may be made in order to achieve the developer's specific goals, such as compliance with application and business related constraints, and that these specific goals will vary from one implementation to another and from one developer to another. Moreover, it will be understood that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking of engineering for those of ordinary skills in the art having the benefit of embodiments of this disclosure.

[0023] Various embodiments of the present invention illustrated in the drawings may not be drawn to scale. Rather, the dimensions of the various features may be expanded or reduced for clarity. In addition, some of the drawings may be simplified for clarity. Thus, the drawings may not depict all of the components of a given apparatus (e.g., device) or method. The same reference indicators will be used throughout the drawings and the following detailed description to refer to the same or like parts.

[0024] The term "system" or "device" is used generically herein to describe any number of components, elements, sub-systems, devices, packet switch elements, packet switches, access switches, routers, networks, modems, base stations, eNB (eNodeB), computer and/or communication devices or mechanisms, or combinations of components thereof. The term "computer" includes a processor, memory, and buses capable of executing instruction wherein the computer refers to one or a cluster of computers, personal computers, workstations, mainframes, or combinations of computers thereof.

[0025] FIG. **1** shows a block diagram of a communication network **100** that includes an exemplary embodiment of a distributed downlink baseband processing system. The network **100** may operate as a fourth generation ("4G"), Long Term Evolution (LTE), Fifth Generation (5G), New Radio (NR), or combination of 4G and 5G cellular network configurations.

[0026] The network **100** includes a central office **102** and remote site **104** that communication with each other using transmission lines **118**. In an embodiment, the central office **102** and remote site **104** are separated by a large distance. The transmission lines **118** are optical fiber or other suitable transmission medium.

[0027] In an embodiment, the central office **102** comprises a baseband processing section (A) **120** that performs first portion of baseband processing to compress and transmit compressed downlink baseband packets **112** to the remote site **104** using the transmission lines **118**. In an embodiment, the baseband processing section (A) **120** also generates configuration parameters **114** that are transmitted to the remote site **104** using the transmission lines **118**. The configuration parameters **114** describe how to decompress the compressed downlink packets **112**.

[0028] The remote site **104** comprises baseband (BB) processing section (B) **106** and an RF interface **108**. The RF interface **108** transmits downlink communications to user equipment, such as user equipment **116**, using antenna **110**. The RF interface **108** receives the downlink communications from the baseband processing section **106**. The BB processing section **106** performs a second portion of baseband processing to receive and decompress the compressed downlink packets **112** according to the received configuration parameters **114**. The decompressed downlink packets are provided to the RF interface for transmission to user equipment.

[0029] Thus, the network **100** illustrates a distributed baseband processing system that efficiently utilizes transmission lines between the central office **102** and the remote site **104**. The baseband processing section (A) **120** performs a first portion of the baseband processing to compress and transmit downlink packets and configuration parameters to the remote site **104**. The remote site **104** performs a second portion of the baseband processing to receive and decompress the compressed packets **112** according to the received configuration parameters **114** to generate downlink packets for transmission to user equipment **116**. The compressed packets **112** contain downlink data in compressed format without loss to efficiently utilize the transmission lines **118**, thereby allowing the use of less expensive transmission line or to allow more channels of information to be transmitted over existing transmission lines. A more detailed description of the distributed baseband processing system is provided below.

[0030] FIG. **2** shows an exemplary detailed embodiment of a central office **102** and remote site **104** shown in FIG. **1**. In an embodiment, the central office **102** includes one or more baseband (BB) DSPs, such as DSP **202**, that are part of the BB processing section (A) **120**. The central office **102** also includes an interface **204** that transmits and receives information over transmission lines **118**. In an embodiment, the DSPs, such as DSP **202**, compress downlink baseband packets and transmit these packets **112** to the remote site **104** using transmission lines **118**. The DSPs also transmit the configuration parameters **114** to the remote site **104** using the interface **204** and transmission lines **118**. In various embodiments, any type of packetized transmission format can be utilized. The configuration parameters **114** describe how the compressed downlink packets **112** are to be decompressed.

[0031] The remote site **104** includes an interface **206** that receives the compressed downlink packets **112** and the configuration parameters **114** and passes this information to a downlink de-compressor **208** that is part of the BB processing section (B) **106**. The decompressor **208** decompresses downlink packets **112** according to the configuration parameters **114** and passes the decompressed downlink packets **218** to one or more RF interfaces, such as RF interface **108**. For example, each RF interface receives downlink packets for transmission using antennas, such as antenna **110**, and converts the received digital downlink packets to an analog signal format using digital-to-analog

(DAC) converters. Thus, the RF interfaces generate analog downlink signals that are transmitted by the antennas **110** to user equipment.

[0032] FIG. **3** shows an exemplary compressed downlink data packet **300** generated by an embodiment of the first baseband processing section **120** and decompressed by an embodiment of the second baseband processing section **106**. During operation, the baseband processing section **120** generates the data packet **300** for each antenna. The data packet **300** includes a header **302** that comprises an antenna index, packet time stamp, and a (frame:slot:symbol number), which identifies the packet. The data packet **300** also includes downlink frontend configuration parameters **304** that are provided when necessary. The data packet **300** also includes subcarrier data **306** that comprise modulation order and transmit data. In an embodiment, the generated data packets **300** can be transmitted from the central office **102** to the remote site **104** in any order.

Configuration Parameters

[0033] In an embodiment, the following is a non-exhaustive list of configuration parameters **304**. It should be noted that in other embodiments, other configuration parameters may be utilized.

1. Antenna index
2. FFT size
3. Number of resource blocks
4. Subcarrier spacing
5. Cyclic prefix size
6. Cyclic delay diversity offset
7. Phase rotation
8. Antenna calibration on/offset
9. Antenna gain
10. Subcarrier shift
11. Beamformer matrix

[0034] FIG. **4** shows an embodiment of a compression format for each resource block of the subcarrier data **306**. For example, the compression format includes a group descriptor **402**, beam index/antenna index **404**, gain index **406**, modulation order **408**, and a plurality of symbols **410**. In an embodiment, the group descriptor **402** has a values of zero or 1 where a zero means empty and a 1 means normal traffic. The beam index/antenna index **404** has a range between [0-(n−1)], which represents a beam or antenna index value. The gain index **406** has a range between [0-(n−1)], which represents a gain index identified in a predefined gain table. The modulation order **408** has a value that represents modulation from BPSK to 256 QAM. Each of the symbols **410** comprise m-bit binary data.

[0035] FIG. **5** shows a detailed embodiment of the baseband processing section (B) **106** that comprises the downlink decompressor **208** shown in FIG. **2**. In an embodiment, the decompressor **208** comprises gain table **502**, symbol mapper **504**, multiplier **506**, and vector processor or multiplier **508**. The symbol mapper **504** receives the symbol data **410** and maps them according to the modulation order **408**. The mapped symbols are input to the multiplier **506** that adjusts the gain based on an output from the gain table **502**. The gain index **406** is used to access the gain table **402**. The gain adjusted symbols output from the multiplier **506** along with the beam index/antenna index **404** are input to the vector multiplier **508**, which performs one of beamforming or antenna mapping functions to generate frequency domain baseband samples **510** to be transmitted. The frequency domain samples **510** are input to one or more frontends, such as front end **512**, which use the frontend configuration parameters **304** to generate time domain samples **514** that are input to RF interfaces (e.g., **108**) where the time domain samples are converted to analog signals for transmission by transmit antennas (e.g., **110**). In various embodiments, the time domain antenna samples are transmitted using one of a 4G, 5G, or Wi-Fi transmission formats.

[0036] FIG. **6** shows an exemplary embodiment of the downlink front end **512** shown in FIG. **5**. In an embodiment, the front end **512** comprises an antenna calibration and scaling circuit **602**, subcarrier mapping circuit **604**, and inverse Fourier transform circuit **606**. The front end **512** also includes a time domain measurement circuit **608**. In an embodiment, the frequency domain baseband samples **510** output from the decompressor **208** are received by the calibration and scaling circuit **602**, which performs calibration and/or scaling function. An output of the circuit **602** is input to the subcarrier mapping circuit **604**, which maps subcarriers. An output of the mapping circuit **604** is input to the inverse Fourier transform circuit **606**, which also adds a cyclic prefix (CP) to generate the time domain baseband samples **514** for transmission.

[0037] FIG. **7** illustrates how embodiments of the distributed baseband compression system transmit downlink signals from a central office to a remote site with greater efficiency than conventional systems. FIG. **7** shows a conventional downlink processing system **702** in which baseband signals are processed at a central office **706** and transmitted over transmission lines **118** to a remote site **704**. All of the baseband processing is performed at the central office so that the transmission lines **118** must carry low efficiency downlink baseband information. For example, transmission parameters and data computed at the central office **706** are transmitted to the remote site over the transmission lines **118**, which results in low efficiency transmission of information.

[0038] In contrast, the distributed baseband compression system **100** operates to perform a first portion of baseband processing at the central office **102**. For example, the BB processing section (A) performs a first portion of the baseband processing at the central office **102**, and the BB processing section (B) performs a second portion of the baseband processing at the remote site **104**. Since a portion of the baseband processing is performed at the remote site **104**, the system **100** generates high efficiency compressed baseband packets at the central office that are transmitted over the transmission lines **118** to the remote site **104** where additional baseband processing is performed. Thus, the transmission lines **118** are more efficiently utilizes by embodiments of the system **100**.

[0039] FIG. **8** shows an exemplary method for performing downlink baseband compression in accordance with exemplary embodiments of a downlink transmission system. For example, the method **800** is suitable for use with the downlink transmission system shown in FIG. **2**.

[0040] At block **802**, baseband symbols in resource blocks are compressed. For example, the central office includes baseband processors **202** that generate baseband symbols in resource blocks for transmission to remote sites. In an embodiment, the baseband processors **202** compress the resource blocks as illustrated in FIG. **3** to form compressed blocks.

[0041] At block **804**, the compressed baseband resource blocks are transmitted to remote sites. For example, the central office **102** uses interface **204** to transmit the resource blocks to the remote site **104** using the transmission lines **118**.

[0042] At block **806**, the compressed resource blocks are received at remotes sites. For example, the compressed resource blocks **112** are received at the remote site **104** by interface **206**.

[0043] At block **808**, the received compressed resource blocks are processed at the remote site by the second baseband processing section **106**. For example, the compressed resource blocks **112** are processed by the downlink decompressor **208**. In an embodiment, the decompressor **208** comprises a symbol mapper **504** that maps the received symbols based on modulation order.

[0044] At block **810**, the gain of the mapped symbols is adjusted. In an embodiment, the decompressor **208** comprises a gain table **502** and multiplier **506** that adjust the gain of the mapped symbols.

[0045] At block **812**, beamforming or antenna mapping is performed to generate frequency domain baseband signals. For example, the vector processor or multiplier **508** performs this operation. The frequency domain baseband signals **510** then flow into a downlink front end **512**.

[0046] At block **814**, the downlink front end performs antenna calibration and/or scaling based on the configuration parameters **304**. For example, the block **602** performs this function.

[0047] At block **816**, the downlink front end performs subcarrier mapping based on the configuration parameters **304**. For example, the block **604** performs this function.

[0048] At block **818**, the downlink front end performs an inverse transform and adds a cyclic prefix based on the configuration parameters **304** to generate time domain signals **514** for transmission. For example, the block **606** performs this function.

[0049] Thus, the method **800** operates to perform downlink baseband compression in accordance with exemplary embodiments of a downlink transmission system. It should be noted that the operations of the method **800** can be modified, added to, deleted, rearranged, or otherwise changed within the scope of the embodiments.

[0050] While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that, based upon the teachings herein, changes and modifications may be made without departing from the exemplary embodiments of the present invention and its broader aspects. Therefore, the appended claims are intended to encompass within their scope all such changes and modifications as are within the true spirit and scope of this exemplary embodiments of the present invention.

What is claimed is:

1. A method for facilitating data transmission via a communication network, comprising:

receiving a compressed packet for downlink data containing information relating to gain index, symbols, and modulation order sent from a central office to a remote site via a first transmission medium;

obtaining a gain parameter from a gain lookup table in a downlink decompressor in accordance with the gain index;

generating one or more mapped symbols based on the symbols and the modulation order; and

multiplying the mapped symbols with the gain parameter to generate gain adjusted symbols for facilitating data transmission via a second transmission medium.

2. The method of claim **1**, further comprising generating frequency domain baseband samples associated to one or more antennas in response to the gain adjusted symbols and beam index.

3. The method of claim **2**, further comprising activating an antenna calibration and scaling circuit to obtain information relating to antenna calibration and scaling.

4. The method of claim **1**, further comprising activating a subcarrier mapping circuit to obtain for mapping subcarrier in response to information relating to antenna calibration and scaling.

5. The method of claim **1**, further comprising activating an inverse Fourier transform circuit to generate time domain antenna samples based on information relating to subcarrier mapping and antenna calibration and scaling.

6. The method of claim **1**, further comprising generating time domain antenna samples associated with one or more antennas in accordance with the frequency domain baseband samples and configurable parameters.

7. The method of claim **1**, further comprising performing a second portion of baseband processing to decompress the compressed packets using the configuration parameters to generate the downlink data.

8. The method of claim **7**, further comprising transmitting the downlink data to a user equipment via a wireless transmission network.

9. The method of claim **1**, wherein receiving a compressed packet includes identifying a header within each of compressed packets and configuration parameters associated with each of the compressed packets.

10. The method of claim **1**, wherein receiving a compressed packet includes identifying an antenna index, packet time stamp, frame number, slot number, and symbol number in a header of the compressed packet.

11. The method of claim **1**, wherein receiving a compressed packet includes identifying subcarrier data in a header of the compressed packet.

12. The method of claim **11**, wherein identifying subcarrier data includes determining one or more symbols as part of the subcarrier data.

13. The method of claim **1**, wherein receiving a compressed packet includes receiving at least one of a group descriptor, beam index, antenna index, gain index, and modulation order parameter.

14. The method of claim **1**, further comprising performing at least one of antenna scaling, subcarrier mapping, and inverse Fourier transform functions on frequency domain baseband samples based on configuration parameters to generate time domain antenna samples.

15. The method of claim **14**, further comprising transmitting the time domain antenna samples as part of downlink data to one or more antennas.

16. The method of claim **15**, wherein transmitting the time domain antenna samples includes forwarding the downlink data to its destination utilizing a 5G wireless transmission network.

17. A method for distributed baseband processing of network communication, comprising:

obtaining, by a remote site, configuration parameters from a central office via a communication network through transmission lines;

receiving, by the remote site, downlink packets carrying user data transmitting to a user equipment via a wireless network;

decompressing the downlink packets in accordance with the configuration parameters to obtain frequency domain ("FD") baseband samples; and

generating time domain ("TD") antenna samples in response to the FD baseband samples via a downlink decompressor.

18. The method of claim **17**, further comprising transmitting the TD antenna samples from the remote site to one or more antennas for downlink transmission via the wireless network.

19. The method of claim **17**, wherein receiving downlink packets includes identifying information relating to gain index, symbols, and modulation order sent from a central office to a remote site via a first transmission medium.

20. The method of claim **17**, wherein decompressing the downlink packets includes obtaining a gain parameter from a gain lookup table in a downlink decompressor in accordance with the gain index.

21. The method of claim **17**, wherein decompressing the downlink packets includes generating one or more mapped symbols based on the symbols and the modulation order.

22. The method of claim **17**, wherein decompressing the downlink packets includes multiplying the mapped symbols with the gain parameter to generate gain adjusted symbols for facilitating wireless data transmission.

23. An apparatus for facilitating network communication, comprising:

a central office for facilitating a first portion of downlink transmission and configured to generate compressed packets by compressing downlink data in accordance with configuration parameters wherein each of the compressed packets includes a header that includes an antenna index, packet time stamp, frame number, slot number, and symbol number;

a remote site coupled to the central office for facilitating a second portion of downlink transmission and configured to decompress the compressed packets in accordance with the configuration parameters to generate a plurality of time domain ("TD") antenna samples; and

an antenna coupled to the remote site and configured to transmit the plurality of TD antenna samples to a user equipment via a wireless transmission network.

24. The apparatus of claim **23**, wherein the central office includes frontend configuration parameters.

25. The apparatus of claim **23**, wherein the central office includes transmit data containing symbols and descriptors, beam index, antenna index, gain index, and modulation order parameter.

26. The apparatus of claim **23**, wherein the remote site includes an interface configured to receive the compressed packets via a first transmission.

27. The apparatus of claim **23**, wherein the remote site includes a downlink de-compressor of a second baseband processing section configured to decompress the compressed packets in accordance with the configuration parameters to extract the downlink data.

28. The apparatus of claim **23**, wherein the remote site includes a radio frequency ("RF") interface able to transmit the downlink data to a user equipment via one or more antennas.

29. The apparatus of claim **28**, wherein the RF interface is capable of transmitting TD antenna samples from one or more antennas utilizing one of a 4G, 5G, or Wi-Fi transmission format.

30. The apparatus of claim **23**, wherein the remote site further includes a symbol mapper that utilizes the modulation order parameter and the data to perform symbol mapping to generate mapped symbols.

31. The apparatus of claim **23**, wherein the remote site further includes a gain lookup table that outputs a gain parameters based on the gain index.

32. The apparatus of claim **23**, wherein the remote site further includes a multiplier that multiplies the mapped symbols with the gain parameter to generated gain adjusted symbols.

33. An apparatus for facilitating data transmission via a communication network, comprising:

means for receiving a compressed packet for downlink data containing information relating to gain index, symbols, and modulation order sent from a central office to a remote site via a first transmission medium;

means for obtaining a gain parameter from a gain lookup table in a downlink decompressor in accordance with the gain index;

means for generating one or more mapped symbols based on the symbols and the modulation order; and

means for multiplying the mapped symbols with the gain parameter to generate gain adjusted symbols for facilitating wireless data transmission.

34. The apparatus of claim **33**, further comprising means for generating frequency domain baseband samples associated to one or more antennas in response to the gain adjusted symbols and beam index.

35. The apparatus of claim **33**, further comprising means for activating an antenna calibration and scaling circuit to obtain information relating to antenna calibration and scaling.

36. apparatus of claim **33**, further comprising means for activating a subcarrier mapping circuit to obtain for mapping subcarrier in response to information relating to antenna calibration and scaling.

37. The apparatus of claim **33**, further comprising means for activating an inverse Fourier transform circuit to generate time domain antenna samples based on information relating to subcarrier mapping and antenna calibration and scaling.

38. The apparatus of claim **33**, further comprising means for generating time domain antenna samples associated with one or more antennas in accordance with the frequency domain baseband samples and configurable parameters.

39. The apparatus of claim **33**, further comprising means for transmitting time domain antenna samples as part of downlink data to one or more antennas.

40. The apparatus of claim **39**, wherein means for transmitting the time domain antenna samples includes means for forwarding the downlink data to its destination utilizing a 5G wireless transmission network.

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